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METHOD AND DEVICE FOR THE PRODUCTION OF DIAPERS OR SIMILAR PRODUCTS WITH AT LEAST ONE ELASTICALLY STRETCHABLE SEGMENT

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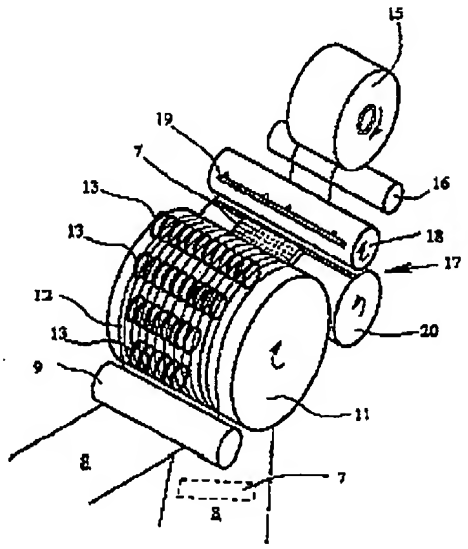
The subject matter of the present invention relates to a method for the production of diapers or similar products with at least one elastically stretchable segment as well as to a suitable device for its production. In this method, a non-elastic layer (8) is provided with pleats and crimps running in the transverse direction (transverse to the longitudinal direction) of the stretch element (6) and is stabilized in this condition. The non-elastic layer (8) is connected to an elastic layer (7). The elastic layer (7), which is stretchable in the longitudinal direction, is not stretched while being connected. The direction of movement during the production is the transverse direction of the normally strip-like stretch element, which is stretchable in the longitudinal direction and which comprises the elastic layer (7) that is stretchable in the longitudinal direction and at least one non-elastic layer (8). Thus, in this production stage, the forward direction of the fabric is also the direction of movement of the overall diaper production line, thereby ensuring a continuous passage through the diaper production line.



The subject matter of the present invention relates to a method for the production of a diaper or a similar product with the characteristics of the preamble of Claim 1 and a suitable device for the production of said diaper with the features of the preamble of Claims 11 and 12.

The invention relates to the production of diapers or similar products with at least one elastically stretchable segment. In the context of the present invention, diapers are intended to include baby diapers, on the one hand, and adult diapers, on the other hand, but also other incontinence products and textile fabrics suitable for said products. Thus, the teaching of the invention covers not only diapers in the strict sense of the term, such as especially baby diapers, but, in addition to adult diapers, for example, also panty shields, sanitary napkins, incontinence pants (training pants), other similar personal hygiene products, and textile products, in particular, suitable pants, all of which products have in common that they have at least one elastically stretchable segment, especially in the area of the waistband. Thus, whenever hereinafter reference is made to a "diaper," it should be remembered that the generic products mentioned above are also included in the discussion. The use of the term "diaper" thus serves only to simplify the explanation and to signal the fact that baby diapers and adult diapers are only a special area of application of the present invention.

The elastically stretchable segment in the known diapers is implemented in that disposed in this segment is a preferably strip-like stretch element that is stretchable in the longitudinal direction and comprises an elastic layer that is stretchable in the longitudinal direction and at least one non-elastic layer, the entire surface of which is connected, in particular, glued or sealed by means of ultrasonic sealing, to said elastic layer, the non-elastic layer of which stretch element is pleated or crimped when the elastic layer is not stretched, and extended and flat when the elastic layer is fully stretched. Such examples can be found, for example, in the European Patent EP-B-0 323 040; a production method of this type is the subject matter, e.g., of U.S. Patent US-A-4,735,673.

In general, the stretch element can comprise not only a two-layer combination, i.e., elastic layer/non-elastic layer, but also a three-layer combination, i.e., non-elastic layer/elastic layer/non-elastic layer. In the two-layer combination of elastic layer/non-elastic layer, this stretch element, along the side of the elastic layer, is in most cases suitably glued or sealed to the base fabric of the diaper.

So far, stretch elements have often been produced by connecting, especially gluing or sealing, the entire surface of the elastic layer in its stretched condition to the non-elastic layer, so that the non-elastic layer is automatically pleated or crimped when the external holding tension is removed from the elastic layer or the stretch element. Thus, gathering the elastic layer crimps or pleats the non-elastic layer.

The production technique discussed above can be implemented using longitudinally stretchable fabric for the elastic layer, in which case the continuously passing fabric of the elastic layer is stretched in the longitudinal direction (by means of two stretch rollers connected in series and operating at different rotation speeds of a stretching station). One problem of this method is

that the direction of movement during the production, i.e., the direction of the longitudinal stretch of the elastic layers, runs transverse to the direction of movement of the diaper production line as such. Attaching the stretch element, which is stretched in the longitudinal direction, to the base fabric of the diaper requires a transfer step at a 90° angle, which is difficult to implement in rapidly operating production lines and which is invariably complex as far as both the equipment and control technology are concerned.

The method known from U.S. Patent US-A-4,735,673, on the other hand, works with a transversely stretchable fabric for the elastic layer, so that the direction of stretch of the elastic layer is the same as the transverse direction of the diaper production line. Thus, a transfer at a 90° angle is not necessary; however, the stretch step has to be implemented transverse to the direction of movement of the elastic layer itself. The result is that grippers have to be used to grip the longitudinal edges of the initially continuously passing fabric strip for the elastic layer, and that the fabric must be stretched in the transverse direction and must be held in this stretched condition and must be connected to the non-elastic layer. This requires additional fabric just to make available the working surfaces for the transverse grippers. Relative to the length of the stretch element, superfluous edge strips comprise approximately 25 to 30% of the fabric. This increases the production costs considerably, since approximately 80% of the production cost of such stretch elements is the cost of the fabric, which stretch elements thus in turn represent a considerable cost factor in the overall production. When a transversely stretchable fabric is used for the elastic layer, an additional problem is that, in contrast to PU foam, the modern skin-friendly "fluted elastic material" is extremely thin and at risk of being easily torn so that it is hardly possible to use it in a method in which transverse stretching is used.

The problems discussed above have already been recognized, and a solution has already been proposed in which the advantages of production with a longitudinally stretchable fabric coincide as nearly as possible with the advantages of production with a transversely stretchable fabric. The fundamental idea for the prior art on which this invention is based, is that during production, the elastic layer is not stretched longitudinally but is instead connected, unstretched, to the non-elastic layer and the non-elastic layer is pleated or crimped prior to connecting it to the elastic layer (German Patent DE-A-30 16 197, European Patent EP-A-0 182 942).

In the prior art discussed above, the direction of movement during the production is the same as the longitudinal direction of the stretch element. In the device used for the production, appropriate grooves are disposed in the axial direction along the jacket of a pleating roller.

The explanations above, however, indicate that in spite of all the advantages of the above-discussed prior art that forms the starting point for the teaching of this invention, the previously discussed problem arises again, i.e., that in order to channel the stretch element into the diaper production line, a transfer at a 90° angle is required. This means that the method

discussed above does not fully achieve the simultaneous advantages of production with longitudinally stretchable and transversely stretchable fabric.

Thus, the problem to be solved by the present invention is to design and improve the production method discussed above so that all advantages of production with a longitudinally stretchable fabric and production with a transversely stretchable fabric are simultaneously achieved and to ensure that this method is as inexpensive as possible. The subject matter of the present invention also relates to a suitable production device.

In a method having the features of the preamble of Claim 1, the problem defined above is solved by the features of the characterizing portion of Claim 1. With the measures suggested by the invention, the longitudinal direction of the stretch element is oriented transverse to the direction of movement during the production, i.e., also transverse to the continuous passage in the diaper production line. This makes it possible for the stretch element to be channeled into the diaper production line without a transfer at a 90° angle.

Preferred embodiments and improvements of the method according to the present invention are the subject matter of Claims 2 to 10. Claims 11 and 12 each describe a useful manufacturing device.

The invention will be explained in greater detail below on the basis of a drawing that illustrates only various practical examples. In the drawing,

Figure 1 shows a highly diagrammatic perspective representation of a conventional baby diaper used today,

Figure 2 shows a perspective representation of a partial area of a device for manufacturing a diaper according to the present invention,

Figure 3 shows a diagrammatic side view of the partial area shown in Figure 2, and

Figure 4 shows a differently designed partial area of a device for manufacturing a diaper according to the present invention.

As explained earlier, the term diaper here covers a large number of products made of a cellulose/synthetic fabric with at least one elastically stretchable segment, preferably disposed in the area of the waistband, i.e., for example, for use in panty shields and sanitary napkins and textile products.

The diaper represented in Figure 1 comprises, first of all, an upper layer 1 (in technical jargon: a top sheet), which, when worn, is in contact with the skin and is permeable to fluids, a fluid-absorbent core made of either defibered cellulose alone or of a mixture of defibered cellulose and a super-absorbent fabric, and a lower layer 2 (back sheet) that is impermeable to fluids and that, when worn, faces away from the skin and is generally constructed in the form of a PE film.

In some cases, the side of the core facing the skin may also comprise other layers for improving the fluid distribution (distribution layers). Additional layers on the side of the core that faces away from the skin can further enhance the absorption and storage of fluid (acquisition layers).

In the area of the frontal portion on the inner or outer surface of back sheet 2, a strip of film is disposed (frontal tape) that increases the strength of back sheet 2, thus making it possible to close the diaper with two lateral adhesive strips 3 (side tapes).

The remaining design features of diapers with the waist-sealing tape (waist shield), with internal leak-guard strips (standing cuffs), and elastic leg seals require no further explanation since they represent prior art.

Of interest is the elastically stretchable segment 4 (at least one such segment is provided), preferably in the area of the waistband. In the example of a diaper shown in Figure 1, this elastically stretchable segment 4 is disposed not only in the area of the waistband in the front but also in the back. In this example, additional elastically stretchable segments 4 are even disposed in the lateral tabs of the diaper (side flaps). These elastically stretchable segments 4 take the place of the previously discussed fluid barriers (waist shield) and serve as fluid barriers; they provide a good torso fit and they ensure that the diaper does not slip down on the body of the wearer.

The enlarged detail in Figure 1 shows the element with which such an elastically stretchable segment 4 in a diaper is constructed. This element is a longitudinally stretchable stretch element 6 that usually, as in this specific case, has a strip-like design and comprises a longitudinally stretchable elastic layer 7 and at least one non-elastic layer 8, the entire surface of which is connected, in particular, glued or sealed by means of ultrasonic sealing, to said elastic layer. The fabric to be used for elastic layer 7 is mainly a "fluted elastic material," which is especially beneficial to the health of the wearer, while non-elastic layer 8 can be made of regular PE film. The enlarged detail in Figure 1 also shows an additional non-elastic layer 8 on the opposite side of elastic layer 7, i.e., a three-ply stretch element 6.

Furthermore, the enlarged detail in Figure 1 shows that non-elastic layer 8 is pleated or crimped when elastic layer 7 is not stretched, as shown in Figure 1, and is extended and flat when elastic layer 7 is stretched, which is not shown in Figure 1. In this manner, the desired elastic effect is obtained in segment 4.

Diapers of the type discussed here with the previously described known stretch element 6 are known to be designed so that said element is connected, in particular, glued or sealed, to the outside surface of back sheet 2 or to the inside surface of top sheet 1, or even between top sheet 1 and back sheet 2. The lower non-elastic layer 8, dotted in the enlarged detail in Figure 1, can be made of the film material of back sheet 2 of the diaper as such, in which case stretch element 6,

at least in the extended condition, must be connected to the entire surface of the fabric of top sheet 1 and/or back sheet 2 in order to ensure that the fabric of top sheet 1 and/or back sheet 2 is gathered along with elastic 7 layer when said elastic layer contracts.

One alternative, however, is to dispose stretch slots in top sheet 1 and/or back sheet 2 to ensure that as stretch element 6 is stretched, top sheet 1 and back sheet 2 can move with the stretch.

Conventional stretch elements 6 can be stretched by 20% to 100%; in most cases, the stretch is 30% to 50% (length of the stretched stretch element 6 compared to the length of the unstretched stretch element 6).

In segment 4 of the enlarged detail [sic], Figure 1 shows that when viewed in the longitudinal direction, the pleated or crimped non-elastic layer 8 is connected to elastic layer 7 only in sections or at certain points, with unconnected sections located in between.

In the method described, non-elastic layer 8 is provided with pleats or crimps oriented transversely (transverse to the longitudinal direction of stretch element 6) and stabilized in this condition; the pleated or crimped non-elastic layer 8 is connected, in particular, glued or sealed, to elastic layer 7; elastic layer 7, which can be stretched in the longitudinal direction, is not stretched during the above-mentioned processing step, and the stretch element 6 thus produced is fed to the manufacturing stages that follow. The important factor is that with respect to stretch element 6, the direction of movement during production is the transverse direction. Thus, the longitudinal direction of stretch element 6 is correctly oriented transverse to the direction of movement during production, as is desired to ensure continuous passage in the diaper production line.

The method according to the present invention offers the advantages of processing longitudinally stretchable fabrics and transversely stretchable fabrics without the disadvantages of either of these methods. It is advantageous that the method according to the present invention can be carried out with [the fabric] passing through longitudinally, since the forward direction of the fabric of non-elastic layer 8 is the same as the direction of movement of the diaper production line. The fabric of elastic layer 7, which, with regard to the transverse stretch, had been the cause of the aforementioned problems, is processed with respect to the forward direction in the same manner as transversely stretchable fabric, except that there actually is no transverse stretch and thus no risk of tearing and no need for implementing additional lateral edge strips as working areas for transverse stretch grippers. Thus, the fabric consumption for the expensive elastic layer 7 is considerably lower than that required when processing transversely stretchable fabrics in the conventional manner.

In the method of producing the diaper or a similar product, stretch element 6 is subsequently stretched in the longitudinal direction and then fed to the next production stage.

Then, stretch element 6, which has been stretched transversely to the direction of movement of the diaper production line, is connected without difficulty to the fabric of top sheet 1 or back sheet 2 of the diaper on the diaper production line. Alternatively, it is also possible for stretch element 6 to be fed to the next production stage without having been stretched in the longitudinal direction. The manner in which stretch element 6 is further used in the production process, however, is no longer a subject of the present invention.

The method can be implemented by continuously moving non-elastic layer 8 in the direction of movement while said layer is being connected to elastic layer 7.

Figures 2 and 3 show that the flat non-elastic layer 8 is pulled from a storage roller through a pleating station to a connecting station for connecting it to elastic layer 7, and that in the pleating station, starting from the inside and moving outward, it is gradually provided with pleats oriented in the direction of the movement.

The pleating station can be a linear station. A simpler construction is shown in Figures 2 and 3. Here, the continuously entering fabric of non-elastic layer 8 (arrow) is first guided over a deflector roller (9) and subsequently fed under tension maintained by a draw-off roller 10 over a pleating roller 11 having a plurality of annular grooves 12 distributed across the width of said roller and into which the fabric of non-elastic layer 8 is gradually pressed from the inside toward the outside by means of corresponding mating pressure rolls 13 so as to form pleats.

The practical example shown in Figures 2 and 3 shows a preferred embodiment in which non-elastic layer 8 on pleating roller 11 passes four groups of pressure rolls 13 that, in the circumferential direction, are connected in series one behind the other and then passes an adhesive-spreading station 14 and, approximately when leaving pleating roller 11, i.e., when tangentially rolling off pleating roller 11, is connected to unstretched elastic layer 7. Instead of passing through adhesive-spreading station 14, non-elastic layer 8 can also be sealed to elastic layer 7 by means of ultrasonic sealing for connecting it to said layer. Figure 2 clearly shows four groups of pressure rolls 13, each of which mates with the associated annular groove 12. It is important to note that the first group of pressure rolls 13 mate only with the annular grooves 12 located in the midsection of pleating roller 11, while each following group of pressure rolls 13 downstream thereto mates with the other more outwardly disposed annular grooves 12. Thus, the downstream groups of pressure rolls 13 are invariably active in the annular grooves 12 with which the previous groups of pressure rolls 13 had already mated earlier.

In the practical example shown in Figure 2, one can see that the first group comprises six pressure rolls 13, the second group comprises eight pressure rolls 13, the third group has ten pressure rolls 13, and the fourth group has twelve pressure rolls 13. One can also see how the pressure rolls 13 gradually draw in the outer edges of the passing fabric of non-elastic layer 8 from the outside toward the inside. The tension maintained in the passing fabric of non-elastic

layer 8 by draw-off roller 10 ensures that the fabric of non-elastic layer 8 is held in the annular grooves 12, on the bottom of which grooves the pleating roll 11 has a smaller diameter.

In Figure 3, it can be seen that in adhesive-spreading station 14, an adhesive is applied onto the surface of non-elastic layer 8, which is stabilized on the wider circumference of pleating roller 11 and which in the connecting station leads to a connection with the fabric of elastic layer 7.

As to elastic layer 7, this layer is continuously drawn off a storage roller 15 and is fed via two deflector and calender rollers 16 to a cut-and-slip station 17. In the application example shown, cut-and-slip station 17 has a cutting roller 18 with a cutting blade 19 and a vacuum roller 20 that retains a strip of elastic layer 7 on surface 1 of said vacuum roller, as shown in Figure 2, even after it has been cut. Vacuum roller 20 has a peripheral speed that is higher than the feeding speed of the fabric strip of elastic layer 7 from storage roller 15, thus ensuring that the individual strips of elastic layer 7 are appropriately spaced.

In Figure 3, one can see that a strip of elastic layer 7 on the vacuum roller 20 of cut-and-slip station 17 is applied to the continuously passing non-elastic layer 8 where it is drawn off by the draw-off roller 10 approximately at the moment when it leaves pleating roller 11, i.e., when it tangentially rolls off pleating roller 11. In Figure 2, a previously attached strip of elastic layer 7 can be seen.

The purpose of showing the width of the material strip of the non-elastic fabric to which elastic layer 7 has been applied, as seen in Figure 2, is to indicate that in this case the production method used is one that subsequently employs transverse stretch. But since this is of no importance in the context of the teaching of the present invention, it will not be discussed further.

The application example of a production device shown in Figure 4 does not have a plurality of groups of pressure rolls 13, which in the peripheral direction are connected in series, but has two pressure rollers 13',13" located upstream of pleating roller 11, each of which combines a group of pressure rolls 13. Non-elastic layer 8 is also fed under tension over these additional pressure rollers 13',13". It can be seen that pressure roller 13' mates with annular grooves 12 on pleating roller 11, while pressure roller 13" mates with annular grooves 12 that are formed on pressure roller 13'. Preferably, the mating here also proceeds from the inside to the outside. Otherwise, the device of Figure 4 is identical to that of Figures 2 and 3.

Claims

1. A method for the production of diapers or similar products with at least one elastically stretchable segment (4), preferably disposed in the waistband area,

with a longitudinally stretchable, preferably strip-like stretch element (6) being disposed in this segment (4) of the diaper, with this stretch element comprising an elastic layer (7) that can

be stretched in the longitudinal direction of stretch element (6) and at least one non-elastic layer (8), the entire surface of which is connected, in particular, glued or sealed, to said elastic layer, with the non-elastic layer (8) of which stretch element being pleated or crimped when the elastic layer (7) is not stretched, and being extended or flat when the elastic layer (7) is stretched,

with the non-elastic layer (8) being provided with pleats or crimps that are oriented in the transverse direction (transverse to the longitudinal direction of the stretch element (6)) and being stabilized in this condition,

with the pleated or crimped non-elastic layer (8) being connected, in particular, glued or sealed, to the elastic layer (7),

with the longitudinally stretchable elastic layer (7) not being stretched in the processing step just mentioned,

with the stretch element (6) thus produced being fed to the subsequent manufacturing stages,

characterized in that

the direction of movement during production is the transverse direction relative to the stretch element (6).

2. The method as described in the preceding claim characterized in that the elastic layer (7) is made of a flat synthetic material, possibly of PU foam, but especially of a fluted elastic material and/or that the non-elastic layer (8) is made of a polyethylene film and/or that two non-elastic layers (8) are connected to the top sheet and the back sheet of the elastic layer (7), either simultaneously or one after the other.

3. The method as described in one of the preceding claims, characterized in that the non-elastic layer (8) is moved continuously in the direction of movement while it is being connected to the elastic layer (7).

4. The method as described in one of the preceding claims, characterized in that the flat non-elastic layer (8) is pulled from a storage roller through a pleating station to a connecting station for connecting it to the elastic layer (7) and that in the pleating station, starting from the inside and moving outward, it is provided with pleats oriented in the direction of the movement and preferably that of the pleating station, the non-elastic layer (8) is fed under tension over a pleating roller (11) that has a plurality of annular grooves (12) distributed across the width of said pleating roller and into which the fabric of the non-elastic layer (8) is pressed by means of corresponding mating pressure rolls (13) so as to form pleats.

5. The method as described in any one of the preceding claims, characterized in that the pleating progresses from the inside toward the outside.

6. The method as described in any one of the preceding claims, characterized in that on the pleating roller (11), the non-elastic layer (8) passes a plurality of, in particular four, groups of pressure rolls (13), which, in the peripheral direction, are serially disposed one behind the other.

7. The method as described in any one of the preceding claims, characterized in that the pressure rolls (13) associated with the pleating roller (11) are combined in a pressure roller (13'), over which the non-elastic layer (8) is guided under tension and/or that an additional group of pressure rolls (13) is combined in an additional pressure roller (13"), over which the non-elastic layer (8) is guided under tension and mates with the first pressure roller (13')

8. The method as described in any one of the preceding claims, characterized in that the non-elastic layer (8), after passing the pressure rolls (13), passes through an adhesive-spreading station (14) and is connected to the unstretched elastic layer (7) approximately at the point at which it leaves the pleating roller (11), i.e., when it tangentially rolls off the pleating roller (11) and/or in that the non-elastic layer (8), instead of passing through an adhesive-spreading station (14), is sealed by means of ultrasonic sealing to the elastic layer (7), so as to connect it to said elastic layer.

9. The method as described in any one of the preceding claims, characterized in that the elastic layer (7) is continuously drawn off a storage roller (15) and fed to the connecting station and, while continuously passing through said station, is connected to the non-elastic layer (8) and that subsequently this composite system is cut into individual strip-like stretch elements (6).

10. The method as described in any one of the preceding claims, characterized in that the elastic layer (7) is continuously drawn off a storage roller (15) and is cut into strips in a cut-and-slip station (17) and that the strips are applied at certain intervals in the direction of the movement and that the thus spaced strips of the elastic layer (7) are subsequently connected in the connecting station to the continuously passing pleated fabric of the non-elastic layer (8).

11. A device for the production of diapers or similar products with at least one elastically stretchable segment (4), preferably in the waistband area, with a longitudinally stretchable, preferably strip-like stretch element (6) being disposed in this segment (4), with the stretch element comprising an elastic layer (7) that can be stretched in the longitudinal direction of the stretch element (6) and at least one non-elastic layer (8), the entire surface of which is connected, in particular, glued or sealed, to said elastic layer, with the non-elastic layer (8) of said stretch element being pleated or crimped when the elastic layer (7) is unstretched and being extended or flat when the elastic layer (7) is stretched, in particular, to carry out a method as described in any one of Claims 1 to 10, characterized

by a pleating roller (11) having a plurality of annular grooves (12) that are distributed across its width,

by a plurality, preferably four groups, of pressure rolls (13), that in the peripheral direction of the pleating roller (11), are connected in series one after the other, with each of said pressure rolls mating with an associated annular groove (12),

optionally by an adhesive-spreading station (14) disposed in the peripheral direction downstream of the last group of pressure rolls (13) or by an ultrasonic sealing station and a draw-off roller (10) or a similar device that holds the fabric of the non-elastic layer (8) that continuously passes over the pleating roller (11) under tension,

with the first group of pressure rolls (13), when viewed in the direction of rotation of the pleating roller (11), only mating with the annular grooves (12) located in the midsection of the pleating roller (11) and with each of the subsequent groups of pressure rolls (13) mating, in particular, additionally, with the next more outward-lying annular grooves (12).

12. A device for the production of diapers or similar products with at least one elastically stretchable segment (4), preferably in the waistband area, with a longitudinally stretchable, preferably strip-like stretch element (6) being disposed in this segment (4), with the stretch element comprising an elastic layer (7) that can be stretched in the longitudinal direction of the stretch element (6) and at least one non-elastic layer (8), the entire surface of which is connected, in particular, glued or sealed, to said elastic layer, with the non-elastic layer (8) of said stretch element being pleated or crimped when the elastic layer (7) is unstretched and being extended or flat when the elastic layer (7) is stretched, in particular, to carry out a method as described in any one of Claims 1-10, characterized

by a pleating roller (11) having a plurality of annular grooves (12) that are distributed across its width,

by a pressure roller (13') that combines a plurality of pressure rolls (13), each of which mates with its associated annular groove (12), being guided under tension over the non-elastic layer (8),

optionally by an additional pressure roller (13") that combines a plurality of pressure rolls (13), with this pressure roller (13") mating with the pressure roller (13'), and with the non-elastic layer (8) being guided under tension over this pressure roller (13");

optionally by an adhesive-spreading station (14) disposed in the peripheral direction on the pleating roller (11) downstream of the last group of pressure rollers (13") or by an ultrasonic sealing station, and

by a draw-off roller (10) or a similar device that keeps the fabric of the non-elastic layer (8), which continuously runs over the pleating roller (11) and the pressure roller (13' or pressure rollers 13',13"), under tension,

with the number of annular grooves (12) that the pressure roller (13') forms for the pressure roller (13") preferably being smaller than the number of the annular grooves (12) on the pleating roller (11).

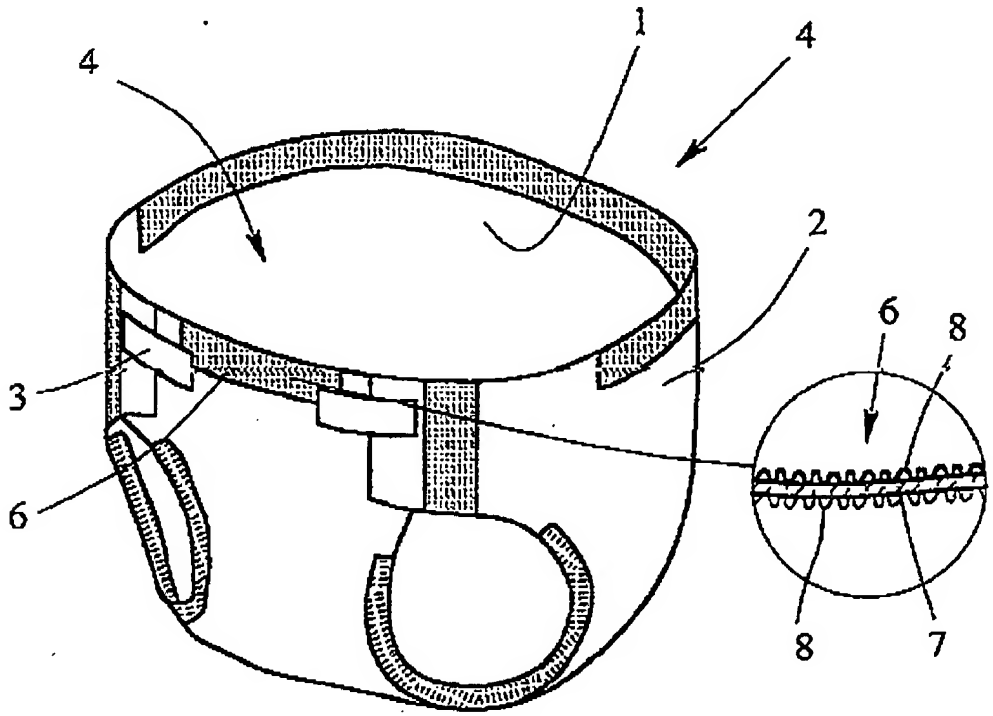


Figure 1

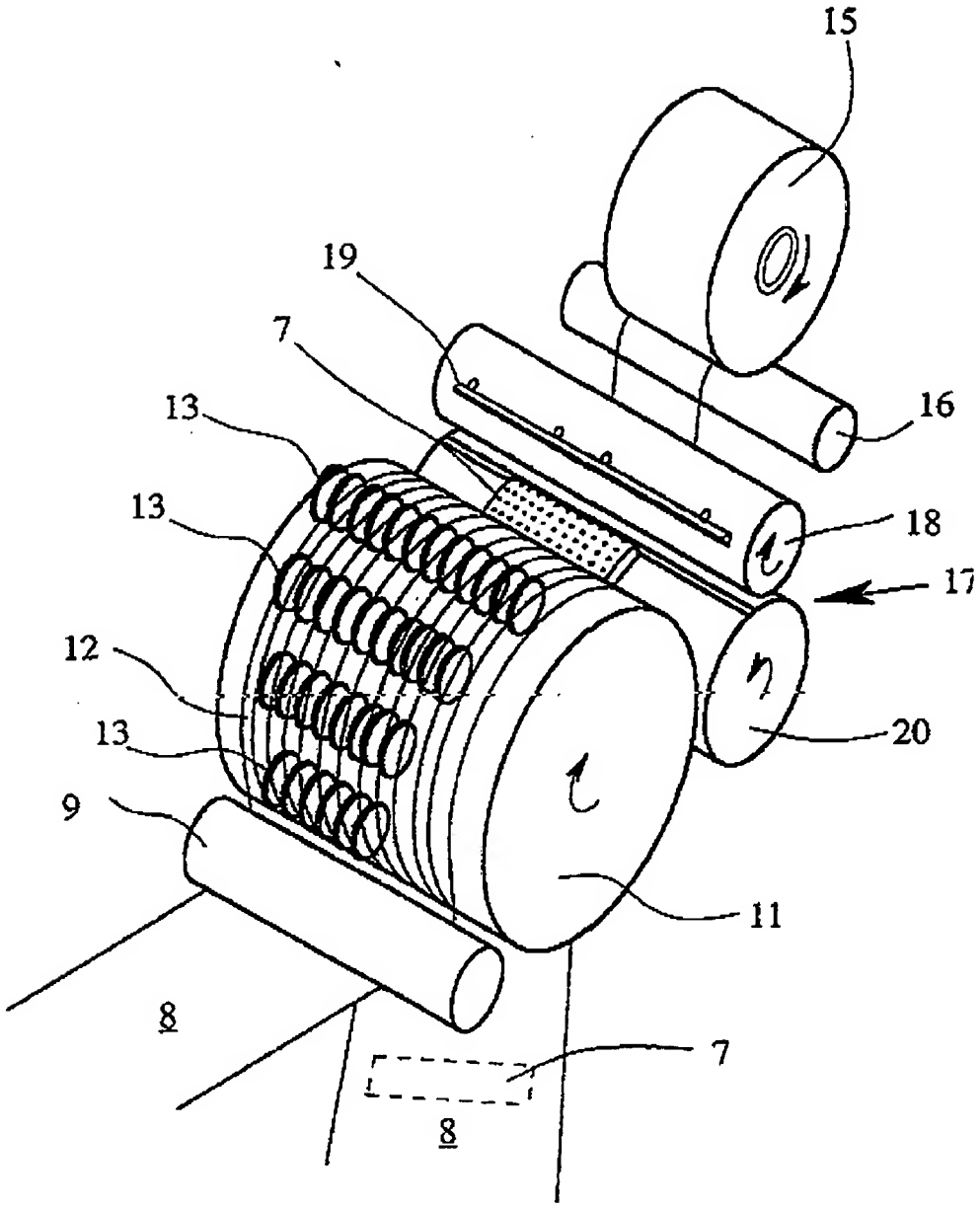


Figure 2

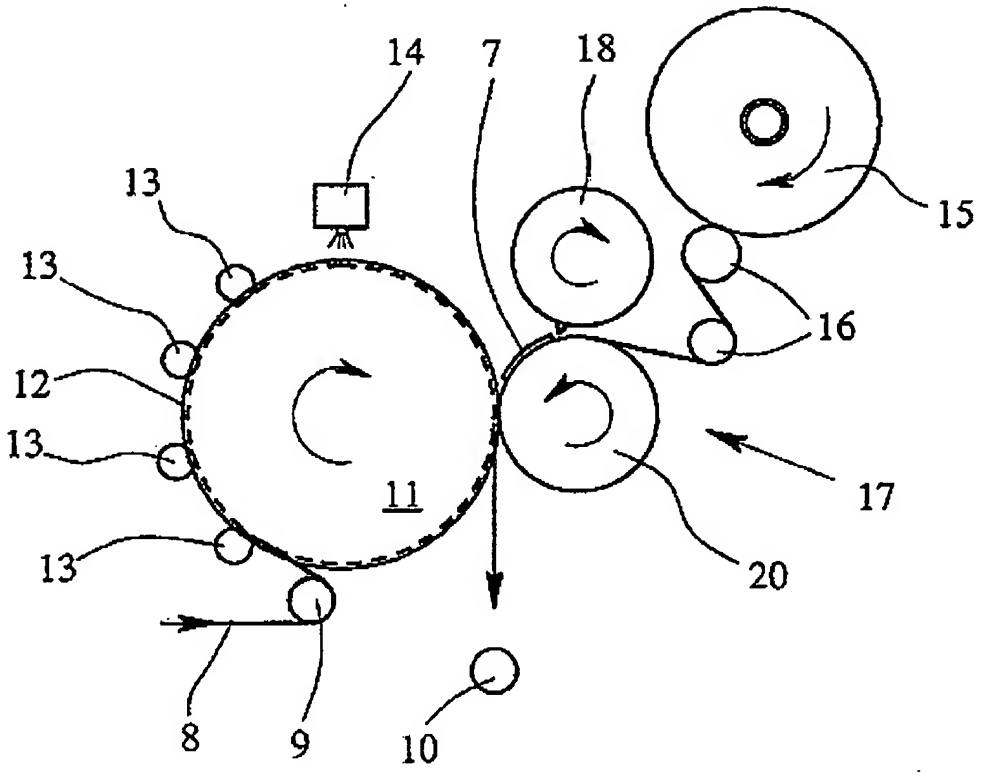


Figure 3

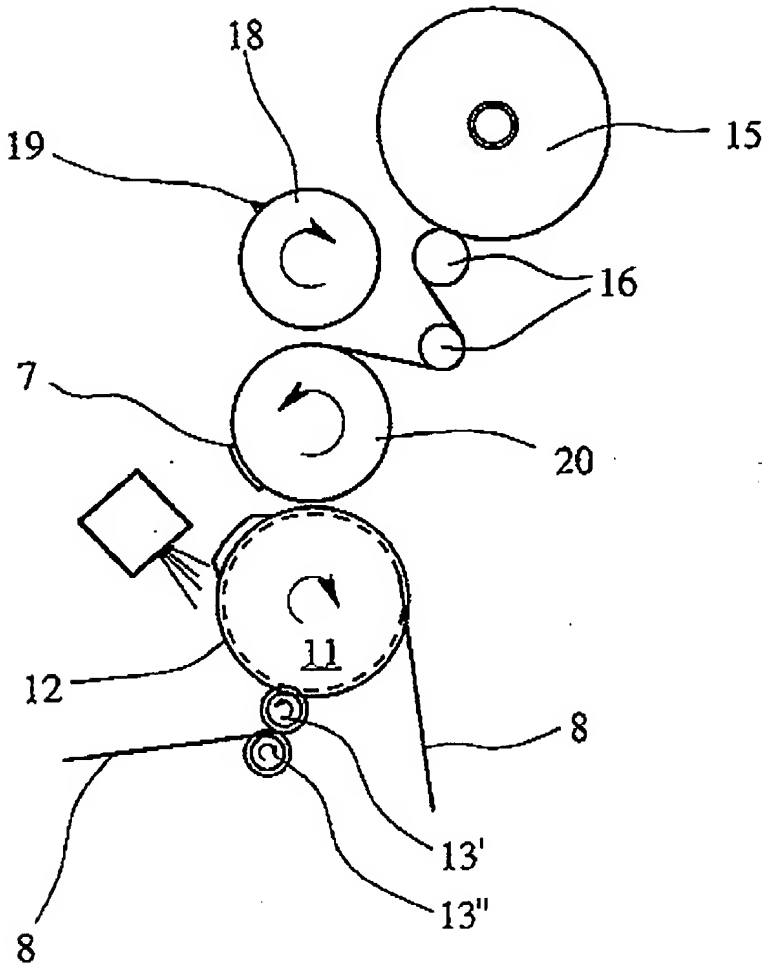


Figure 4